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SOLID WASTE COMPOSITION STUDY FOR IQALUIT, PANGNIRTUNG, AND BROUGHTON ISLAND OF THE NORTHWEST TERRITORIES. / Heinke, Gary W.; Wong, Jeffrey. 1990.

P.L. Heaney

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By

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I. INTRODUCTION

1.1 Background

Solid waste disposal in the Northwest Territories has been receiving much public attention in the past years. In many communities, local officials have recognized that inadequate solid waste disposal facilities and management may potentially pose serious threats to the health and welfare of its residents and create adverse environmental effects. Consequently, there currently exists a strong public demand for effective and efficient solid waste disposal which, in many cases, may only be achieved through redesigning and/or relocating the existing facilities.

Essential information for planning of improved solid waste disposal facilities include the quantity (volume and weight) and composition of wastes, which must be disposed of in NWT communities. Very little reliable information exists unfortunately.

1.2 Purpose of the Study

The purpose of the study is to determine the composition and quantity of solid wastes which are typically disposed at solid waste disposal sites in communities of the Northwest Territories. Three communities in the Baffin Region, Iqaluit, Pangnirtung, and Broughton Island were selected as representative communities for undertaking the study. Results of comprehensive composition and quantity studies from these communities will be compared with results from other waste composition studies performed in the Northwest Territories and elsewhere. In addition, the methodology of carrying out such a study and the problems involved will be addressed.

1.3 Potential Benefits

A comprehensive knowledge of solid waste composition and quantity is beneficial for the following applications:

- evaluation of alternative waste management approaches
- size of the waste management facility
- equipment selection
- evaluation of waste recycling opportunities
- assessment of potential health and environmental hazards

At present, the majority of solid waste disposal operations in the Northwest Territories consist of open dumps or modified landfills. To fully evaluate the benefit of alternative solid waste disposal, waste composition and quantity information is essential. For example, if a high percentage of combustible garbage is available, it may be feasible to incinerate the generated wastes. To design and operate an incinerator and to evaluate its efficiency, the BTU content of the solid waste fuel must be determined from composition studies. For the purpose of planning landfills, information of gross quantities and compaction properties are required. Even bailing or shredding operations require such information to evaluate their effectiveness and feasibility. Information collected from such a study may also be useful for identifying the possibility of system mixing. For example, the potential for shredding or incineration in combination with landfilling could be evaluated.

The number, type and capacity of collection vehicles required is directly related to the quantity and type of wastes generated. Smaller communities generate lower volumes of garbage and a single stake truck or Haul-all unit may be sufficient to accommodate the waste stream. In larger communities, two or more collection vehicles, particularly packer trucks, may be required to handle the waste stream. Packer trucks of different capacity are available and per capita generation rates can aid in the selection process. Other equipment to be selected include bulldozers, graders and front end loaders, trenchers or other earth moving vehicles.

If recycling is to become a component of the solid waste management plan, detailed classification is required. It is not cost-efficient to recycle components which do not have recycling potential in terms of cost or volume. The results from this study, supported by similar studies in other parts of the N.W.T. could be used to identify which components have some potential for recycling.

Data regarding food waste generation is useful for determining potential health hazards associated with putrescible wastes and their potential for attracting animals to the waste disposal site. Of particular concern is the attraction of birds to disposal sites [1] near airports and the problem of air safety. The quality of garbage also affects leachates and gaseous emissions from landfill sites which could potentially be harmful to the public or the environment.

1.4 Existing Solid Waste Composition Studies

Estimates of solid waste composition in the Northwest Territories are available from a 1974 study by D. Forgie for Environment Canada [2]. This study examined the composition of solid waste from three communities to develop data for incinerator design and simulation of solid wastes from small northern communities and work camps. The three sites selected were Frobisher Bay (presently Iqaluit), Resolute and Tuktoyaktuk. This is the only study of this type for N.W.T. communities and has limited use. The study considered only the percent by weight and heating values for each waste class. Volume data were not considered. Since the study was completed 15 years ago, it is very probable that solid waste composition and quantity has changed over this period and the data may no longer be applicable to today's situation.

An authoritative study to estimate solid waste composition was undertaken by Bird and Hale Ltd. for Environment Canada in 1977 [3]. The study involved a field sampling program at 26 sites in eleven Canadian municipalities with a population of 100,000 or greater. This study is commonly used by municipalities in the south but may have little use in northern communities where the populations are considerably smaller, the lifestyle is different, and the climatic conditions are more severe.

Other studies have been performed in other parts of the world. The most relevant of these to the Northwest Territories are studies performed in Anchorage, Alaska. Unfortunately it was not possible to track down the report or publication for proper referencing. However, since these studies were carried out on work camps, they may not be directly relevant for communities. A summary of solid waste composition studies from past studies is provided in Table 1.

Table 1 SUMMARY OF SOME EXISTING SOLID WASTE COMPOSITION STUDIES

Classification	Percent by Weight of Total Sample						
	Frobisher Bay Forgie, 1974 [2]		Resolute Forgie, 1974 [2]		Tuktoyaktuk Forgie, 1974 [2]	Anchorage Mun. Study, 1972	Anchorage Melelak, 1978
	1	2	1	2			
Cans	10.1	10.6	10.6	13.0	11.7	1.25	1.25
Other Metals	1.1	3.1	8.4	10.7	2.5	8.75	9.25
Glass	13.4	6.1	4.5	6.9	13.6	14.50	7.0
Plastics	4.2	6.3	7.9	5.3	10.1	5.0	5.9
Paper	24.9	16.3	14.8	13.8	26.8	43.7*	49.9*
Rags	4.4	7.3	1.4	9.8	4.4	2.1	2.1
Potrescibles	22.8	38.7	37.0	22.0	15.9	21.7	21.7
Wood	0.3	2.8	1.2	3.2	5.3	1.2	1.2
Cardboard	17.3	8.3	11.4	8.9	6.4	--	--
Dirt	1.4	0.5	2.8	6.4	3.3	1.7	1.7
Total	99.9	100.0	100.0	100.0	100.0	99.9	100.0

* includes cardboard wastes

II COLLECTION AND SORTING

2.1 Possible Study Approaches

Several approaches have been recognized and have been used in past studies. Different approaches do not necessarily represent differences in opinion regarding how to proceed but rather they reflect the different purposes of the studies. The type of approach used will depend upon the type of information required. A study for the purpose of incinerator design will seek information regarding combustible fractions and moisture contents. For the purpose of planning landfills, gross quantities and composition properties will be of most concern. Other purposes may require information on the potential quantities of recyclable wastes or information on the commercial/industrial solid waste stream.

Four approaches which can be applied to communities in the Northwest Territories are discussed below. They recognize that most NWT communities are small.

2.1.1 Hand Sort of Entire Truckload

This approach involves manually sorting raw wastes from entire truckloads in order to determine the physical composition of wastes. Since many truckloads arrive at the disposal site daily, it is important that selected trucks provide a good representation or cross-section of the waste stream of interest. A detailed knowledge of the routes serviced by the selected trucks is necessary for this approach to yield reliable information. In most northern communities, the foreman of Public Works is fully knowledgeable with the areas serviced by the collection vehicles and can thus advise on the vehicles to be selected for sorting.

By sorting the entire truckload, the issues of obtaining an appropriate size sample and deciding upon an appropriate method of taking samples from the truckload are avoided.

The greatest disadvantage of sorting an entire truckload is that a great deal of sorting effort is required. Truckloads range in size from 500 pounds of uncompacted wastes for a typical 1/2 ton pickup to 10,000 pounds of compacted wastes for a typical 20 cubic yards packer truck. The effort may be better spent sorting smaller samples from a greater number of representative truckloads.

2.1.2 Curbside Pick Up at Selected Locations

When source specific data are of interest the normal collection route may be adjusted so that collection occurs from selected locations only. For example, if commercial waste data are required, only wastes from commercial establishments will be collected and sorted. The merit of this approach is that very detailed results can be achieved since wastes from specific areas or even specific buildings can be targeted for analysis.

Re-routing the collection scheme to accommodate this approach requires the cooperation of the collection crew. Experience has proven that collection crews are hesitant to cooperate as re-routing disrupts their daily collection routine and could result in lost time. If this study method is to be used, it is essential to have the agreement and cooperation of the communities administrators.

Demographic data of the selected locations must be obtained so that per capita generation routes can be derived. Such information is available from the local housing authority.

2.1.3 Questionnaire Survey

A questionnaire survey similar to the one attached in Appendix A can be carried out and the results summarized to establish waste characterization data.

This is a common approach for commercial/industrial establishments, however its reliability is solely dependent upon the thoroughness with which the establishments complete the survey.

2.1.4 Random Sample of Waste

The most widely used method of solid waste composition analysis requires the selection of random samples from the entire waste stream and then hand sorting the samples into specified categories. This concept of selecting random samples from truckloads of waste may appear simple to the uninitiated, but in practice it proves to be a challenging task. To obtain useful and statistically reliable information, statistically valid and representative samples must be established. This demands that much attention be given to sample size and the method by which samples are selected.

2.1.4.1 Sample Size

The task of sorting wastes is labour intensive and time consuming. In all but the smallest communities it is practically impossible to separate, measure and analyse all of the solid waste generated by a community. Accordingly, representative samples need to be selected which are characteristic of the total waste population.

For statistical reliability, it is necessary to be able to determine the size of the sample needed to obtain a desired level of precision. Klee and Carruth (4) addressed this problem of an appropriate sample size in a 1970 study. The purpose of their work was to study precision as it varied with the weight of the sample.

Klee and Carruth examined the variances of three sample weight groups: 1,400 - 1,700 lb., 700 - 900 lb. and 200 - 300 lb. to determine if there was any discernible pattern. They concluded that there were no important or significant differences among precisions for the studied sample weight groups of 200 lb or greater. Small samples of 200 - 300 lb are as adequate in determining the composition of solid waste as a larger sample of up to 1,700 lb.

In a study conducted by Bird and Hale (3) to determine municipal refuse composition statistics for Canadian communities over 100,000 population, a sample size of 400 lb. was found to be sufficient.

Based on these observations, it is concluded that small samples (200 - 300 lb.) will be as statistically valid as large samples for the purpose of composition analysis.

2.1.4.2. Number of Samples

The number of samples required to achieve an acceptable level of accuracy was determined by Klee and Carruth (4) using the following normal approximation.

$$n = (\underline{zs})^2$$

Where:

n = number of samples required
z = normal standard deviate (one tailed) for confidence level desired
s = estimated standard deviation, transformed basis
= sensitivity (transformed basis)

The sensitivity can be determined as follows:

$$= 2 \arcsin x - 2 \arcsin x_{\pm}$$

Where:

x = expected percentage value of a component expressed as a decimal
= desired accuracy ($\pm 2\%$, $\pm 4\%$, etc.)

At the 90% confidence interval, $z = 1.645$, and $s = 0.1632$.

Example calculations have been worked out (5) and are shown in Figure 1. This plot of number of samples versus expected component % illustrates that if an expected percentage of 5% is to be analysed within $\pm 2\%$ accuracy at a 90% level of confidence, then 10 samples are required.

2.1.4.3. Sampling Technique

The issue of how to take a sample from a truck load of waste in a manner that will provide a truly representative sample requires careful consideration. If one was to merely dig through a pile of wastes in an effort to select a "random" sample, human nature would normally cause one to select the easiest wastes to sort, effectively biasing the sample. In order not to bias the samples, the cone and quartering technique should be used.

In the cone and quartering technique, the entire truckload is pushed into a cone shaped pile and then divided into quarters using a shovel or other appropriate tool. One section is selected and similarly divided until a sample of the required size is reached.

In the modified cone and quartering technique the pile of waste is divided into an arbitrary number sections and the sorters are assigned a particular section from which they are instructed to select samples which appear to be representative of their sections.

2.2 METHODOLOGY

To adequately assess solid waste composition any one or combination of the approaches outlined in section 2.1 could be selected. However, due to time and budget constraints, only the Random sample of waste approach (sec. 2.1.4.) was utilized to carry out the study in the three NWT communities.

2.2.1. Selection of Communities

Three communities from the Baffin Region were selected to carry out the study; the basic selection criterion was population size. A small size community (100 - 700 residents), medium size community (700 - 2,000 residents), and a large size community (> 2,000 residents) were sought to identify possible differences in waste composition with community population. The three selected communities with their respective population and location data are shown in Table 2.

TABLE 2
POPULATION AND LOCATION OF SELECTED COMMUNITIES

COMMUNITY	POPULATION 1986 Census	LOCATION
Iqaluit	2947	63° 45'N, 68° 31'W
Pangnirtung	1004	66° 09'N, 65° 43'W
Broughton Island	439	67° 33'N, 64° 02'W

For financial and administrative reasons the decision was made to select three communities only, and in one administrative region. The Baffin region was selected by MaCa officials for ease of getting the study going quickly.

Iqaluit is the largest community in the eastern Arctic so it was chosen to represent the large community. Iqaluit was also selected because it was the subject of a similar study conducted by D. Forgie in 1974 (2). Updated solid waste composition data would be useful for identifying changes in waste composition over the past 15 years. Pangnirtung and Broughton Island were selected to represent the medium and small communities respectively.

2.2.2. Classification Scheme

The composition of solid wastes received at any disposal facility is inherently heterogeneous. In order to facilitate the sorting process and to achieve useful results, the categories of any classification scheme must possess the following properties:

- categories must be well defined and easily recognized so that sorters can process the wastes quickly,
- categories must reflect the needs of the study. For example, 'newsprint' rather than 'paper' would be a category if recycling is an issue,
- categories must permit relatively direct comparison with previous and existing data.

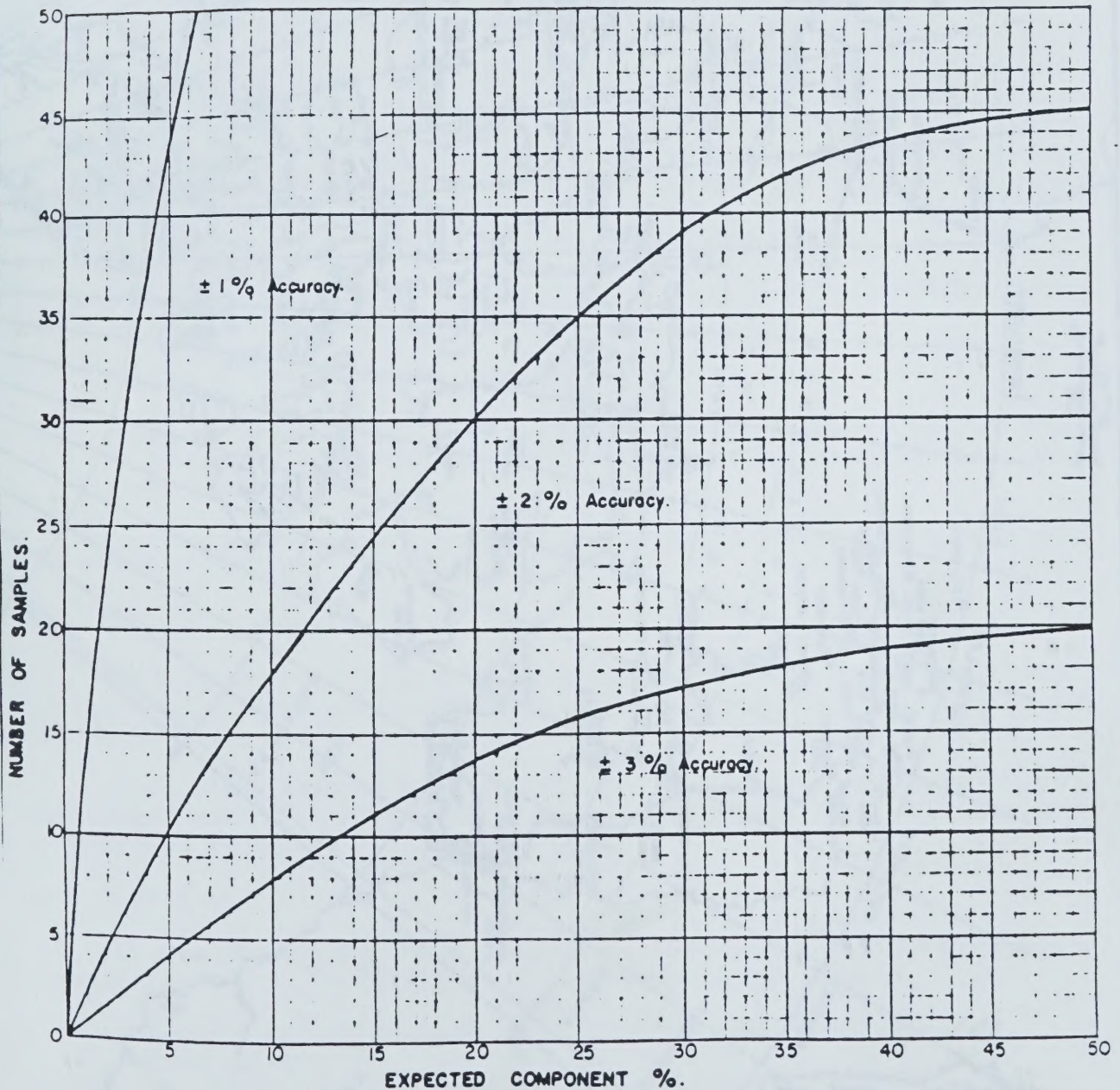
For the purpose of this study, twelve categories were identified:

- food wastes
- cardboard
- newsprint
- other paper products
- cans
- other metal products
- plastic, rubber & leather
- glass and ceramics
- textiles
- wood
- dirt
- diapers

FIG. 1

NUMBER OF SOLID WASTE SAMPLES

REQUIRED TO ACHIEVE A DESIRED ACCURACY
(AT A CONFIDENCE INTERVAL OF 90%)



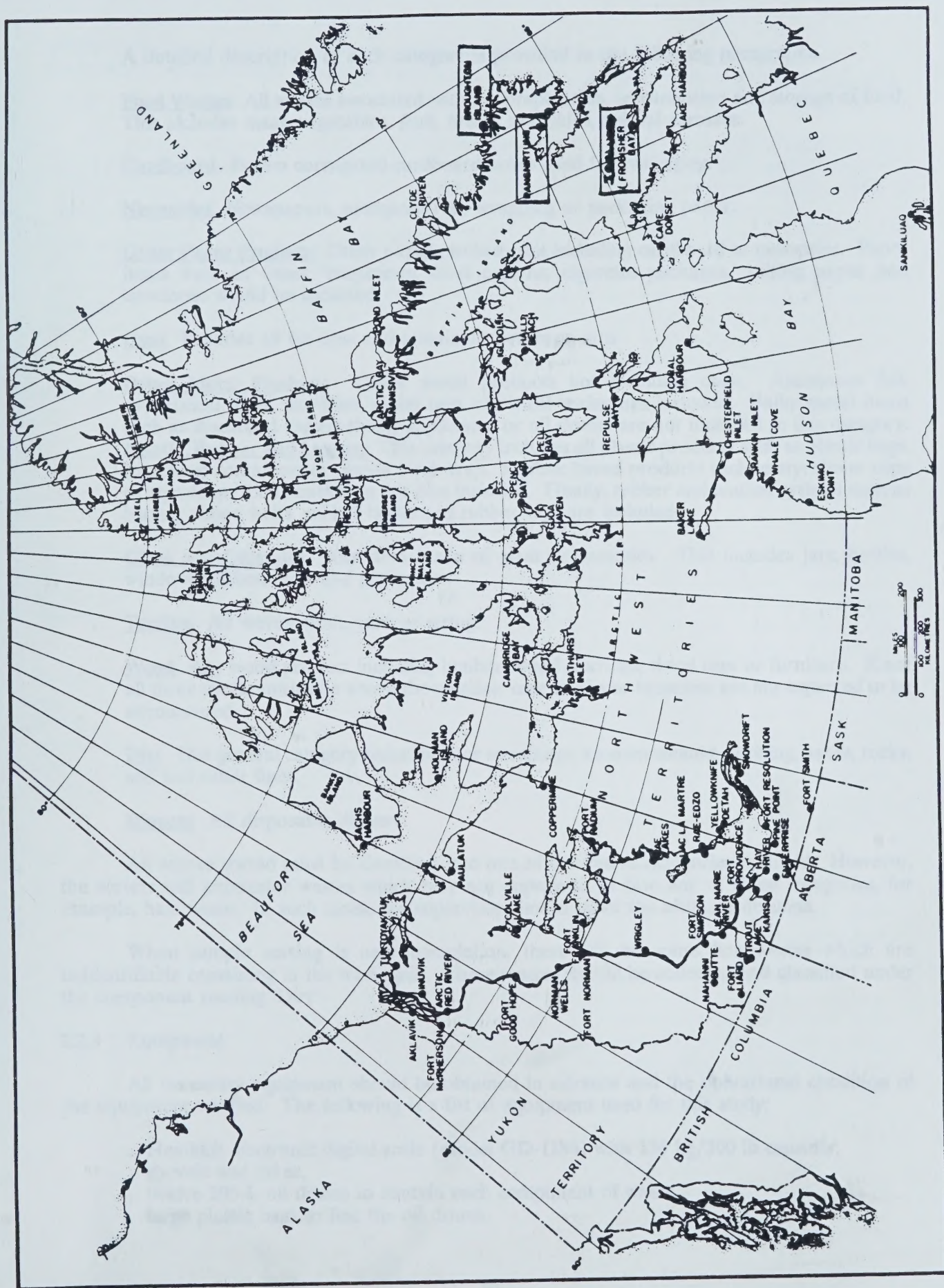


Figure 2. Location of selected communities

A detailed description of each category is provided in the following paragraphs.

Food Wastes All wastes associated with the preparation, consumption and storage of food. This includes meat, vegetables, fruit, bread, seal skins, animal carcasses.

Cardboard Brown corrugated cardboard boxes used for packaging.

Newsprint Newspapers, newsprint type wrapping or packaging paper.

Other Paper Products Other paper products not including cardboard or newsprint. Paper items such as tissue, magazines, food cartons, cigarette packages, writing paper and envelopes would be included.

Cans Includes all tin cans and aluminum beverage cans.

Other Metal Products Other metal products not including cans. Aluminum foil, mechanical parts, batteries, metal toys, electrical wiring are included. Bulky metal items such as discarded snowmobiles, appliances or oil drums are not included in this category.

Plastic, Rubber and Leather This category includes all plastic products such as plastic bags, toys, food containers or plastic food wrap. Styrene based products such as styrofoam cups or styrofoam food containers are also included. Finally, rubber and leather articles such as leather shoes, belts, rubber boots and rubber toys are included.

Glass and Ceramics Any item made of glass or ceramics. This includes jars, bottles, windows, dishes, cups and plant pots.

Textiles All woven cloth, yarn or string.

Wood Any wood product including lumber, wood shavings, wood toys or furniture. Since all three communities lie above the treeline, tree trunks or branches are not expected to be encountered.

Dirt This general category includes floor sweepings, vacuum cleaner catching, ashes, rocks, soil and other fines.

Diapers All disposable diapers.

All wastes sorted must be classified into one of the twelve categories outlined. However, the sorters will encounter wastes which may not appear to fit into any of these categories, for example, hair waste. In such cases, the supervisor should make the ultimate decision.

When sample sorting is near completion, there will be some fine wastes which are unidentifiable remaining in the waste pile. These wastes should be collected and classified under the component reading 'Dirt'.

2.2.3 Equipment

All necessary equipment should be obtained in advance and the operational condition of the equipment verified. The following is a list of equipment used for this study:

- Heathkit electronic digital scale (model GD-1186) with 136 kg/300 lb capacity,
- shovels and rakes,
- twelve 205 L oil drums to contain each component of waste,
- large plastic bags to line the oil drums.

It is important that the safety and health of each crew member be attended to by equipping them with proper protective clothing. Public Health officers in Iqaluit required that all the workers be equipped with the following items:

- . heavy boots, preferably with steel toes and soles,
- . heavy rubberized gloves
- . rubber outerwear such as yellow rain suits,
- . dust masks.

Public health officials stipulated that all protective clothing must be scrubbed clean after each working day to eliminate any possibility of harboring infectious disease. Since the sorting of wastes took place at the disposal facility in all cases, it was important to ensure that fresh water was available at these sites so that workers could wash their hands as required. In addition, because of the remoteness of the sorting sites, a first aid kit was always readily available so that any cuts or accidents could be attended to immediately.

In Iqaluit, a small wooden shed was brought to the disposal site by the Town and served as a change room/office.

2.2.4 Sorting

Prior to sorting, the disposal site was visited to identify any potential problem areas. In Iqaluit and Broughton Island, waste was sorted outdoors at the disposal sites. It was important to ensure that the chosen site was large enough to carry out the sorting operation safely and yet not interfere with the daily operation of the dump. When possible, sites upwind from the working face of the dump were selected to avoid smoke or odour irritations. In Pangnirtung, waste was sorted indoors at the incinerator building so proper ventilation and lighting was essential.

Manual sorting is the only method of accurately determining the physical composition of wastes. Samples of raw wastes were taken from each truckload by the modified cone and quartering technique (sec. 2.1.1.2) and manually sorted into twelve different categories. Large 205 L oil drums lined with plastic garbage bags were used to hold each category of waste while sorting. When a garbage bag became full or too heavy to lift, it was weighed on the platform scale and the weight recorded. The contents of the bag were then discarded and the process repeated until the total sample was sorted and weighed.

It was important that the waste was sorted accurately and consistently. All crew members were briefed about the classification scheme and their expected performance. For example, an item made of metal and plastic was expected to be taken apart; the metal placed in the metals container and the plastic placed in the plastics container.

It should be understood that sorting garbage is an undesirable activity that rapidly becomes tedious and boring. Workers who are not well motivated perform poorly and are not productive; they tend to sort slowly and show disregard to accurate work. Personal experience has shown that paid labourers are more productive than unpaid volunteers. Crew enthusiasm can be maintained at a high level by taking frequent breaks and planning off site activities such as picnic lunches or coffee breaks in town.

2.2.5 Volume Estimation

Annual volumes were determined from past records. In Pangnirtung and Broughton Island, the residents are required to pay a fee per barrel pickup. Consequently, the Hamlet office keeps accurate records of the number of barrels collected from each household and these were used to estimate total annual volumes of solid waste.

In Iqaluit records are kept on the number of truck loads delivered daily to the disposal site. From this information volume estimation can be made.

III. DATA EVALUATION

3.1 Solid Waste Composition Data

The raw data from the solid waste composition survey conducted in Iqaluit, Pangnirtung, and Broughton Island are summarized in Tables 3, 4 and 5 respectively; in each case table 'a' provides the component weight as received and table 'b' the component weight percentage. The overall composition of the wastes in each of the three communities is shown in Tables 3a, 4a, and 5a in the last column. On the other hand in Tables 3b, 4b, and 5b the mean and standard deviation for the percent by weight composition of all the trucks sampled in each of the three communities is shown.

Table 6 is a summary of the mean waste composition (as a weight percentage) of all three communities in tabular form for easy reference.

Table 7 compares the results of this study to other comparable studies: Bird and Hale (3) and Forgie (2).

3.1.1 Iqaluit Data

Field Work for the waste composition study in Iqaluit began on Tuesday June 27, 1989 and continued to Friday June 30, 1989. During this period, eight truckloads of solid waste totalling 4304.1 kg. were characterized. Four truckloads of waste were sampled from Tuesday's collection and four truck loads of waste were sampled from Thursday's collection. Tuesday's and Friday's collection routes are identical and so are Monday's and Thursday's route. Only the small section of Iqaluit covered by Wednesday's collection route was not sampled. It is estimated that approximately 75% of Iqaluit's total waste stream was represented. It is pointed out, that burning of wastes in oil drums at the home is not permitted.

The wastes which arrived at the west 40 dumpsite on Tuesday, June 27 were collected from the areas known as Lower Base, Astro Hill, North Happy Valley and Apex. These wastes represented the area's weekend and Monday wastes. In addition to residential refuse, hospital, high school, hotel, highrise, CBC and GNWT office wastes were included in this waste stream. The effects of the GNWT offices and hospital wastes are shown in Table 3b. Examination of the weight percentage of other paper products for the first four truck loads is significantly greater than that for the last four truck loads.

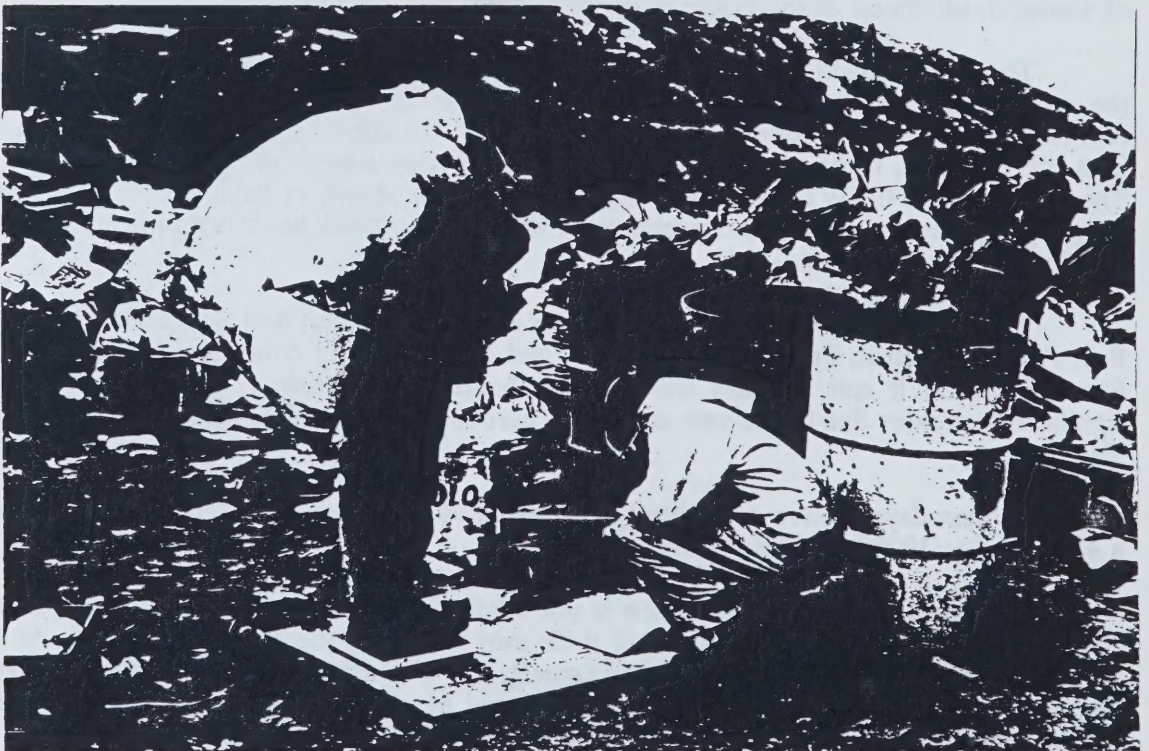
Thursday's collection came from North and South Iqaluit and South Happy Valley. The Bay, Arctic Ventures, Public Health offices, and courthouse all contribute to this waste stream. From Table 3b it can be seen that the cardboard contribution from the last four loads is significantly greater due to the vast amount of cardboard boxes collected from the Bay and Arctic Ventures.

18 man-days (4 men x 4.5 days) were required to process 4304.1 kg. of refuse resulting in a 4.2 man-day/1000 kg. refuse classification rate.

Access to the Iqaluit dump site is not controlled, consequently residents, businesses and construction contractors frequently haul their own wastes to the site for disposal. An informal survey revealed that up to 20 truck loads (mostly 1/2 ton pick up trucks) of refuse arrived at the dump daily. The majority of the wastes consisted of construction wastes such as scrap wood, copper pipes, fibreglass insulation, and electrical wiring.



Photograph 1. Sorting waste at Iqaluit West 40 Dump,
June 27 to June 30, 1989.



Photograph 2. Weighing waste at Iqaluit West 40 Dump,
June 27 to June 30, 1989.

TABLE 3a

DATA SUMMARY OF WASTE COMPOSITION FOR IOALUIT (WEST 40 DUMP): WEIGHT

COMPONENT	LOAD NUMBER								WASTE COMPOSITION	
	kg weight as received								TOTAL	PERCENT BY WEIGHT
	1	2	3	4	5	6	7	8		
Food Wastes	342.1	65.2	140.5	46.8	43.5	138.4	130.6	12.1	919.2	21.4
Cardboard	188.9	68.3	68.9	20.9	67.6	38.6	149.5	17.9	620.6	14.4
Newsprint	111.5	21.2	10.6	7.1	12.9	29.2	14.7	7.1	214.3	5.0
Other Paper Products	353.3	86.2	101.5	45.0	74.6	48.7	50.4	39.0	798.7	18.5
Cans	105.1	18.4	8.9	13.4	33.8	27.8	14.2	12.2	233.8	5.4
Other Metal Products	17.0	51.8	22.6	9.3	3.1	29.8	1.6	35.5	170.7	4.0
Plastic, Rubber, Leather	176.0	80.3	42.1	26.2	60.4	72.0	65.1	49.0	571.2	13.3
Glass, Ceramics	64.7	6.9	9.0	10.6	7.0	20.1	11.5	5.1	134.9	3.1
Textiles	57.0	9.8	12.0	8.9	2.5	29.4	5.6	26.5	151.7	3.5
Wood	24.0	32.7	5.8	1.8	8.9	44.0	13.1	63.5	193.8	4.5
Dirt	43.2	20.6	8.6	12.9	8.4	37.2	2.8	12.5	146.2	3.4
Diapers	21.1	19.7	20.6	13.8	3.6	46.0	17.1	7.1	149.0	3.5

TABLE 3b

DATA SUMMARY OF WASTE COMPOSITION FOR IOALUIT (WEST 40 DUMP): PERCENT WEIGHT

COMPONENT	LOAD NUMBER								Variation in Composition among truck loads	
	(Percent by Weight)								MEAN	STD DEV
	1	2	3	4	5	6	7	8		
Food Wastes	22.7	13.6	31.1	21.6	13.3	24.7	27.4	4.2	19.8	8.8
Cardboard	12.6	14.2	15.3	9.6	20.7	6.9	31.4	6.2	14.6	8.3
Newsprint	7.4	4.4	2.3	3.3	4.0	5.2	3.1	2.5	4.0	1.7
Other Paper Products	23.5	17.9	22.5	20.8	22.9	8.7	10.6	13.6	17.6	5.9
Cans	7.0	3.8	2.0	6.2	10.4	5.0	3.0	4.2	5.2	2.7
Other Metal Products	1.1	10.8	5.0	4.3	0.9	5.3	0.3	12.4	5.0	4.5
Plastic, Rubber, Leather	11.7	16.7	9.3	12.1	18.5	12.8	13.7	17.0	14.0	3.1
Glass, Ceramics	4.3	1.4	2.0	4.9	2.1	3.6	2.4	1.8	2.8	1.3
Textiles	3.8	2.0	2.7	4.1	0.8	5.2	1.2	9.2	3.6	2.7
Wood	1.6	6.8	1.3	0.8	2.7	7.8	2.7	22.1	5.7	7.1
Dirt	2.9	4.3	1.9	5.9	2.6	6.6	0.6	4.3	3.6	2.0
Diapers	1.4	4.1	4.6	6.4	1.1	8.2	3.6	2.5	4.0	2.4
TOTAL SAMPLE WEIGHT	1504.0	481.1	451.1	216.7	326.3	561.2	476.2	287.5		

3.1.2 Pangnirtung Data

Waste composition results from the Hamlet of Pangnirtung are similarly presented in Table 4a and b. 908 kg. of solid waste was classified over three separate days; Thursday, July 6, Monday, July 10, and Tuesday, July 11 1989. Since it required 5 man-days (2 men x 2.5 days) to sort 908 kg. of waste, the refuse classification rate was determined to be 5.5 man-day/1000 kg. As a result of the relatively small size of the community, the collection vehicle can service the entire Hamlet each day. Accordingly, the results presented in Table 4 are representative of the entire waste stream.

Sorting was conducted in the incinerator building, not at the dump site. Consequently, only wastes collected by the collection crew or wastes hauled to the incinerator building by private individuals were sampled. A small number of truck loads of wastes (about 4 1/2 ton pickup trucks) hauled by private individuals were not sampled because they did not dispose the wastes at the incinerator building, instead they hauled their wastes directly to the dump site for disposal. Construction waste from the new school building, scrap wood, roofing material, plumbing materials and fibreglass insulation, and excess packaging wastes from the general store were among the wastes not sampled.

Burning of wastes in oil drums at the home is not permitted.

3.1.3 Broughton Island Data

Solid waste was sorted in Broughton Island on Friday July 14, Monday, July 17, and Tuesday July 18, 1989. In total, 1470.3 kg. of garbage was classified. This required 7.5 man-days (3 men x 2.5 days) to sort resulting in a 5.1 man-day/1000 kg. refuse classification rate. As in Pangnirtung, the collection vehicle serviced the entire community each day so the tabulated results of Tables 5 a and b are representative of the entire waste stream for the study period.

During the study period only a single truck load of wastes consisting of old furniture carpeting and some scrap wood was disposed of at the dump by a private individual. Construction wastes from new residential construction were collected by the collection crew and sampled. Tables 5a and b include construction wastes.

Burning of wastes in oil drums at the home is not permitted.

TABLE 4a

DATA SUMMARY OF WASTE COMPOSITION FOR PANGNIRTUNG: WEIGHT

COMPONENT	DAY NUMBER			TOTAL	PERCENT BY WEIGHT		
	kg weight as received						
	1	2	3				
Food Wastes	59.7	80.4	35.4	175.5	19.3		
Cardboard	65.7	34.1	10.5	110.3	12.3		
Newsprint	1.1	1.3	0.9	3.3	0.4		
Other Paper Products	56.7	59.1	22.0	137.8	15.2		
Cans	18.9	20.4	10.9	50.2	5.5		
Other Metal Products	13.9	17.3	4.2	35.4	3.9		
Plastic, Rubber, Leather	26.5	33.9	19.1	79.5	8.8		
Glass, Ceramics	8.8	7.1	7.4	23.3	2.6		
Textiles	21.2	12.4	3.7	37.3	4.1		
Wood	59.3	58.1	4.5	121.9	13.4		
Dirt	6.3	17.1	4.5	27.9	3.1		
Diapers	30.3	42.4	32.8	105.5	11.6		
				TOTAL			
				907.9 kg	100%		

TABLE 4b

DATA SUMMARY OF WASTE COMPOSITION FOR PANGNIRTUNG: PERCENT WEIGHT

COMPONENT	DAY NUMBER (percent by weight)			MEAN	STD DEV
	1	2	3		
Food	16.2	21.0	22.7	20	3.4
Cardboard	17.8	8.9	6.7	11.1	5.9
Newsprint	0.3	0.3	0.6	0.4	0.2
Other Paper Products	15.4	15.4	14.1	15.0	0.8
Cans	5.1	5.3	7.0	5.8	1.0
Other Metal Products	3.8	4.5	2.7	3.7	0.9
Plastic, Rubber, Leather	7.2	8.8	12.3	9.4	2.6
Glass, Ceramics	2.4	1.9	4.7	3.0	1.5
Textiles	5.8	3.2	2.4	3.8	1.8
Wood	16.1	15.1	2.9	11.4	7.3
Dirt	1.7	4.5	2.9	3.0	1.4
Diapers	8.2	11.1	21.0	13.4	6.7
TOTAL SAMPLE WEIGHT (kg)	368.5	383.6	155.9		

TABLE 5a

DATA SUMMARY OF WASTE COMPOSITION FOR BROUGHTON ISLAND: WEIGHT

COMPONENT	DAY NUMBER kg weight as received			TOTAL	PERCENT BY WEIGHT
	1	2	3		
Food	130.2	47.5	56.3	234.0	15.9
Cardboard	61.2	10.8	64.8	136.8	9.3
Newsprint	2.1	0.9	1.4	4.4	0.3
Other Paper Products	79.9	50.2	76.0	206.1	14.0
Cans	35.3	23.6	13.9	72.8	5.0
Other Metal Products	27.3	19.6	48.1	95.0	6.5
Plastic, Rubber, Leather	57.6	40.8	32.8	131.2	8.9
Glass, Ceramics	8.3	8.5	8.1	24.9	1.7
Textiles	15.3	24.1	9.7	49.1	3.3
Wood	87.1	46.6	161.1	294.8	20.0
Dirt	13.8	9.6	46.9	70.3	4.8
Diapers	34.3	89.0	27.6	150.9	10.3
			TOTAL	1470.3 kg	100%

TABLE 5b

DATA SUMMARY OF WASTE COMPOSITION FOR BROUGHTON ISLAND

COMPONENT	DAY NUMBER			MEAN	STU DEV
	(percent by weight)				
	1	2	3		
Food	23.5	12.8	10.3	15.5	7.0
Cardboard	11.1	2.9	11.8	8.6	4.9
Newsprint	0.4	0.2	0.3	0.3	0.1
Other Paper Products	14.5	13.5	13.9	14.0	0.5
Cans	6.4	6.4	2.5	5.1	2.3
Other Metal Products	4.9	5.3	8.8	6.3	2.1
Plastic, Rubber, Leather	10.4	11.0	6.0	9.1	2.2
Glass, Ceramics	1.5	2.3	1.5	1.8	0.5
Textiles	2.8	6.5	1.8	3.7	2.5
Wood	15.8	12.5	29.5	19.3	9.0
Dirt	2.5	2.6	8.6	4.6	3.5
Diapers	6.2	24.0	5.0	11.7	10.6
TOTAL SAMPLE WEIGHT (kg)	552.4	371.2	546.7		

3.1.4 Comparison of Waste Composition for NWT Communities

The comparison data summarized in Table 6 show little difference in waste composition between Pangnirtung and Broughton Island, but it identifies some definite differences in waste composition between these two communities and Iqaluit. The following differences are noted:

- the newsprint fraction is significantly greater in Iqaluit than Pangnirtung or Broughton Island,
- the plastic, rubber, leather fraction is greater in Iqaluit,
- the wood fraction is lower in Iqaluit than Pangnirtung or Broughton Island.

The first two differences might be attributed to difference in ethnic distribution. About 1/3 of Iqaluit's population is non-native, while the non-native component is only about 5% in the smaller communities. The non-native influence in Iqaluit is reflected by the fact that three daily newspapers from the south are available in the community. Newspapers comprise the majority of the newsprint component. The greater plastic, rubber, leather fraction in Iqaluit is attributed to a larger plastic component. Plastic shopping bags, plastic food packaging and other plastic products typical of a non-native lifestyle were abundant in Iqaluit's waste stream.

The apparent greater wood component in Pangnirtung and Broughton Island must be interpreted carefully. In Iqaluit, most of the construction wastes (largely scrap wood) were hauled to the disposal site by private contractors and were not sampled, thus their contribution to the waste stream was not accounted for. However, in the two smaller communities, Pangnirtung and Broughton Island, the collection crews routinely picked up construction wastes which were subsequently sampled. Therefore, the differences observed in the wood component of Table 6 do not necessarily reflect differences in wood fraction.

The larger diaper component in Pangnirtung and Broughton Island is directly related to the population boom that is currently being experienced by these communities.

For the predominant method of waste disposal in the Northwest Territories, the open dump/modified landfill, these differences in waste composition are not important. For other purposes such as incineration, recycling, shredding or bailing, they may be highly significant.

TABLE 6

COMPARISON OF WASTE COMPOSITION FOR NWT COMMUNITIES
(from Tables 3a, 4a, and 5a: last column)

COMPONENT	IQUALUIT	PANGNIRTUNG	BROUGHTON ISLAND
	percent by weight		
Food	21.4	19.3	15.9
Cardboard	14.4	12.1	9.3
Newsprint	5.0	0.4	0.3
Other Paper Products	18.5	15.2	14.0
Cans	5.4	5.5	5.0
Other Metal Products	4.0	3.9	6.5
Plastic, Rubber, Leather	13.3	8.8	8.9
Glass, Ceramics	3.1	2.6	1.7
Textiles	3.5	4.1	3.3
Wood	4.5	13.4	20.0
Dirt	3.4	3.1	4.8
Diapers	3.5	11.6	10.3
TOTAL	100.0	100.0	100.0

3.1.5 Comparison of Waste Composition With Other Studies

Table 7 shows significant differences in waste composition between the larger than 100,000 population communities of southern Canada sampled by Bird and Hale (3) and the NWT communities surveyed in this study.

- the paper product fraction is lower in the NWT communities,
- the glass and ceramics fraction is lower in the NWT communities,
- the wood fraction is higher in the NWT communities.

The likely reasons for these observed differences are:

The three communities of the Northwest Territories have less office paper wastes, newspaper wastes and paper food carton wastes in their waste streams than larger Canadian cities. This accounts for their observed lower paper component percentage.

Glass bottles, jars and other glass containers of food products are heavy and consequently expensive to transport to NWT communities. As a result, products packaged in paper or plastic containers are preferred. In addition, the communities selected for this study are 'dry' communities; the sale of alcohol for private consumption is prohibited. The absence of beer bottles or liquor bottles from the waste stream had a significant effect on the glass component fraction.

The wood fraction, in these three NWT communities appears unnaturally high, especially since all of the sites selected were located above the tree line. However, this study was conducted at the peak of the building season and coupled with the fact that all of these communities were experiencing considerable expansion, these results are not unexpected for the time of year in which the study was carried out.

Table 7 also compares the results of the present study in Iqaluit (Col. 4) with the results from a similar study performed in Iqaluit in 1974 (col.2, 3). The comparison reveals that solid waste composition has changed over the past 15 years. In 1989, Iqaluit's solid waste stream contained a lower percentage of food wastes, cans and glass/ceramics, but a higher percentage of plastic and wood products. The reduced food waste fraction is unaccountable, but the reduced can component percentage can be readily explained by the recent implementation of a recycling program for aluminum cans. A return deposit for aluminum 'Pop' cans kept them out of the waste stream. The decreased glass component percentage and the increased plastic component percentage over the past 15 years is likely due to the current widespread use of plastic containers.

TABLE 7

COMPARISON OF WASTE COMPOSITION OF THIS STUDY WITH OTHER STUDIES

COMPONENT	Percent by Weight					
	CANADA BIRD & HALE 1978	IQUALUIT FORGIE 1974		IQUALUIT HEINKE & WONG 1989	PANGNIRTUNG HEINKE & WONG 1989	BROUGHTON ISLAND HEINKE & WONG 1989
	Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6
Food	20.6	22.8	38.7	21.4	19.3	15.9
Garden/Yard waste	5.3	-	-	-	-	-
Cardboard	-	17.3	8.3	14.4	12.1	9.3
Newsprint	42.3	24.9	16.3	5.0	0.4	0.3
Other Paper Products }				18.5	15.2	14.0
Cans				23.5	15.6	14.3
Other Metal Products }	7.0	10.1	10.6	5.4	5.5	5.0
Plastic, Rubber, Leather }		1.1	3.1	4.0	3.9	6.5
Textiles	10.1	4.2	6.3	13.3	8.8	8.9
Glass, Ceramics	8.6	4.4	7.3	3.5	4.1	3.3
Wood	4.1	13.4	6.1	3.1	2.6	1.7
Dirt	1.4	0.3	2.8	4.5	13.4	20.0
Diapers	-	1.4	0.5	3.4	3.1	4.8
		-	-	3.5	11.6	10.3

3.2 SOLID WASTE VOLUME DATA

Solid waste volume generation rates can be estimated from past records. In Iqaluit, the collection crew keeps records of the total number of truckloads collected each day. The Hamlet of Pangnirtung and Broughton Island keep records of the number of barrels collected for billing purposes.

3.2.1 Iqaluit Volume Generation Rate

Complete truckload information was available for the months of March, April and May 1989. Table 8 is a summary of the results.

Table 8 Iqaluit Truckload Data

MONTH	NO. of TRUCKLOADS
March	83
April	73
May	87.5
Average per month	81

Compactor truck capacity = 20 cu. yd. (15.3 m³)
 Population (1989 estimate) = 3167

Solid waste generation rate = $\frac{81 \text{ (trucks/month)} \times 15.3 \text{ (m}^3\text{/truck)}}{3167 \text{ (persons)} \times 30 \text{ (days/month)}} = 0.013 \text{ m}^3\text{/person/day}$

The solid waste generation rate for the Town of Iqaluit is estimated to be 0.013 m³/person/day. Although this figure represents a somewhat compacted volume due to the action of the packer truck, it should be noted that the level of compaction was very low; the uncompacted solid waste generation rate would be slightly greater.

3.2.2 Pangnirtung Volume Generation Rate

The Hamlet charges it is residents a \$3.00 fee for each full oil drum container of waste collected. Each time a drum full of garbage is collected from a house/building, the collector records it on a data sheet. Records were obtained from the Hamlet office for January to December 1988 inclusive and are summarized below in Table 9.

Table 9 Pangnirtung Drum Data

MONTH (1988)	NO. of FULL DRUMS
January	2109
February	2242
March	2523
April	2198
May	2451
June	2588
July	2208
August	1971
September	2309
October	2610
November	2758
December	2652
Average per month	2385

Oil drum capacity = 205 L. = 0.205 m³
 Population (1988 estimate) = 1059

Solid waste generation rate =
 $\frac{2385 \text{ (drums/month)} \times 0.205 \text{ m}^3/\text{drum}}{1059 \text{ (persons)} \times 30 \text{ (days/month)}} = 0.015 \text{ m}^3/\text{person/day}$

The solid waste generation rate for the Hamlet of Pangnirtung is estimated to be 0.015 m³/person/day.

3.2.3 Broughton Island Volume Generation Rate

The Hamlet charges its residents a predetermined fee for each full oil drum container of waste collected. Each time a drum full of garbage is collected, from a house/building, the collector records it on a data sheet. Records were obtained from the Hamlet office for the years 1986, 1987 and 1988 and are summarized in Table 10.

Table 10 Broughton Island Drum Data

MONTH	NO. of FULL DRUMS		
	1986	1987	1988
January	1106	835	1045
February	1019	695	1109
March	996	591	1166
April	939	825	1204
May	875	945	1032
June	791	1009	980
July	1120	1040	873
August	672	523	1146
September	1090	1018	1123
October	1026	987	1110
November	738	1096	1008
December	1496	1181	1071
Average per month	989	895	1073

Oil drum capacity = 205 L = 0.205 m³
 Population (1988 estimate) = 472

Solid waste generation rate (1988) =
 $\frac{1073 \text{ (drums/month)} \times 0.205 \text{ (m}^3\text{)}}{472 \text{ (persons)} \times 30 \text{ (days/month)}} = 0.015 \text{ m}^3/\text{person/day}$

The solid waste generation rate for the Hamlet of Broughton Island is estimated to be 0.015 m³/person/day.

Note: It is possible that the solid waste generation rate estimated for Pangnirtung and Broughton Island is somewhat high, because it is likely that not all drums, when collected, are completely full.

IV STUDY LIMITATIONS

The study has some limitations which should be recognized. However, this does not necessarily reduce the usefulness of any of the presented data for planning or design purposes.

4.1 COMMUNITY SELECTION

All three communities involved in this study are located in the Baffin Region. Caution must be exercised if the results from this study are to be applied to other communities in the Northwest Territories. A similar study should be carried out in at least one other region in the Territories involving three similar sized communities in order to determine if waste composition and volume varies with geographic location or ethnic differences.

4.2 SEASONAL VARIATION

It is generally believed that solid waste composition and generation rates vary somewhat from season to season. This study merely took a 'snapshot of the communities' solid waste stream and may not be fully representative of the waste stream during other parts of the year.

4.2.1 Solid Waste Composition

The timing of this study has raised some concern amongst local officials. It was suggested that the results may not be representative because many of the residents were 'out of town' during the study period. During the summer many of the native people go out on the land to hunt and fish for two to three weeks or longer while others just take the opportunity of good weather to travel. Schools are closed for summer vacation and teachers and students return home to other communities. In addition, summer is the peak tourist season and the transient contribution to the waste stream is a concern. Future studies should be carried out in the fall or winter to determine if any seasonal effects on solid waste composition exist.

4.2.2 Solid Waste Volume

The volume of solid waste generated is expected to vary over the course of the year. Solid waste volume is expected to be high in the spring during Town Clean-up and again in late summer following Sealift when a large volume of packaging materials enter the waste stream.

Figure 3 illustrates monthly volume data for Pangnirtung and Broughton Island. The data were derived from drum collection data of Table 9 and Table 10.

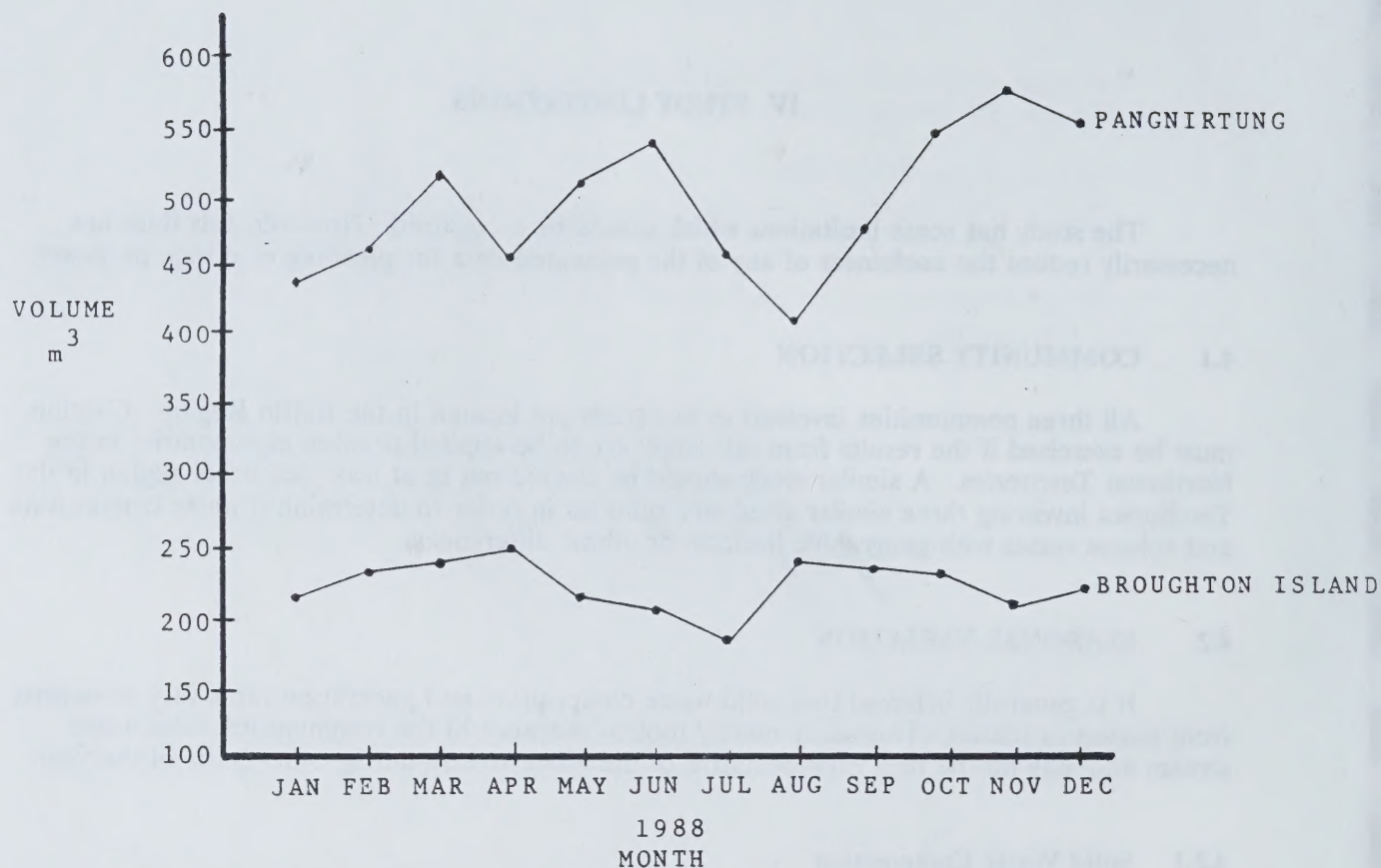


FIGURE 3 MONTHLY SOLID WASTE VOLUME

Similar volume data were not available for the Town of Iqaluit. An attempt was made to estimate the volume indirectly by analyzing fuel consumption totals for the collection vehicle. It should be noted that this is a very crude methods of estimation but it does have some validity despite its limitations. Discussion with the foreman in Iqaluit warned that the garbage truck is left running all day in the winter months to keep the vehicle and the man warm so the fuel consumption should be slightly greater during this period.

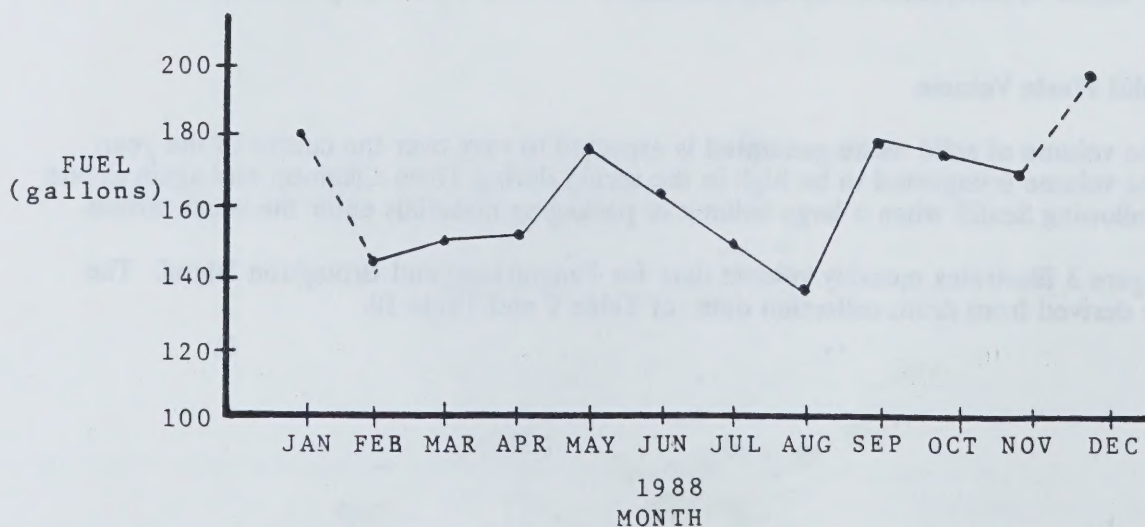


FIGURE 4 MONTHLY IQALUIT COLLECTION VEHICLE FUEL CONSUMPTION

From Figure 3 and Figure 4, it can be shown that less waste is generated in the summer and that waste generation peaks in spring and late summer/early fall. Therefore waste volume generation shows some seasonal variation. As long as an accurate yearly average of waste generation rate is used for design purposes for landfill sites, the seasonal variation are of less importance.

Special wastes were not included in the volume data. Bulky wastes, hazardous wastes and some construction wastes are not normally collected with the 'domestic' wastes by the Town or Hamlet collection crews. Construction wastes could potentially make up a significant volume of the summer waste stream.

4.3 CONSTRUCTION WASTES

A significant amount of solid waste generated during the summer is a result of construction or renovation projects. For example, in Iqaluit up to 20 truckloads (mostly 1/2 ton pickups) of largely uncompacted construction wastes arrived at the dump daily (5 or 6 days per week). A typical 1/2 ton pickup can hold about 2.5 m³ of uncompacted wastes filled level. Thus up to 50 m³ of largely construction wastes arrived at the dump each day. In terms of the waste generation rate, the addition of the construction wastes could almost double the rate from 0.013m³/person/day to 0.024 m³/person/day during the construction season. If four months of construction waste is taken into account then the average waste generation rate for one year is determined to be approximately 0.017 m³/person/day.

A further study should be directed at determining the impact of construction wastes on the operations of disposal facilities.

4.4 BULKY WASTES

Equipment limitations and logistics of determining the bulky waste component prevented the inclusion of these wastes in the study. All of the communities had separate areas for bulky waste disposal so they did not appear at the 'domestic' dump.

4.5 HAZARDOUS WASTES

Hazardous wastes were not included in this study. Future studies to determine the hazardous waste component of the waste stream generation in a community would be beneficial.

V. SUMMARY AND RECOMMENDATIONS

In addition to the waste composition results summarized in Tables 3, 4 and 5 the following conclusions can be made:

- . Very little reliable information was available regarding waste volume and composition generated in NWT communities. In the meantime, a waste generation rate of 0.01 m³/person/day has been used by planners and designers in the Northwest Territories. Even less information is available for composition of wastes.
- . This study has shown that representative and reliable data can be obtained despite the short study period and the use of untrained labour.

- . Any attempt to compare the results obtained here with different studies must be approached with caution. Such factors as component definition, sample size, and number of samples must be considered and understood. Even the quality of the sorting and the attitude of the workers could have significant effects upon the final results.
- . The 'domestic' waste generation rate of the three communities was determined to be between 0.013 and 0.015 m³/person/day of uncompacted wastes. This is 30 - 50% higher than the current accepted waste generation rate. While seasonal variation does occur, this figure represents an average rate over the year.
- . If construction activities in a community are substantial it is to be expected that the average yearly waste generation rate including construction wastes may increase to as high as 0.017 m³/person/day.
- . If construction activities in a community are substantial it is to be expected that the average yearly waste generation rate including construction wastes may increase to as high as 0.017 m³/person/day.
- . Data from the three communities indicate similarities in waste composition amongst some components and substantial variation in waste composition amongst other components. These variations are attributed to population size, ethnic distribution and lifestyle of a community. For this reason we have refrained from providing one typical composition for all NWT communities, instead the waste composition of a large community with a large non-native population as represented by the Iqaluit results should be viewed separately from the waste composition of smaller, mostly native communities which comprise the majority of the communities in the NWT and are represented by the results from Pangnirtung and Broughton Island.

Recommendations

1. Until further information becomes available, the average yearly waste generation volume for NWT communities used for planning and design of waste collection and disposal facilities should be increased from the present 0.010 m³/person/day to 0.014 m³/person/day. If construction activities are substantial in a community this figure should be increased accordingly to as high as 0.017 m³/person/day.
2. Until further information becomes available the waste composition data presented for Iqaluit, Pangnirtung and Broughton Island in Tables 3a, b, 4a, b, and 5a, b should be used for similar size communities elsewhere in the NWT.
3. A similar study should be carried out in at least one other region of the NWT in order to provide additional information on possible differences in waste volume and composition with geographical location, population size and ethnic or cultural differences. Special attention should be placed on the generation of construction wastes and on bulky wastes.
4. A special study on hazardous waste generation and disposal in the Northwest Territories should be carried out.

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APPENDIX A

SURVEY QUESTIONNAIRE

COMMUNITY PROFILE

1.1 Introduction

1.2 Purpose

1.3 Scope

1.4 Method

1.5 Results

1.6 Conclusion

APPENDIX B

COMMUNITY PROFILES

B.1. Igualdad

B.1 Iqaluit

B.2 Pangnirtung

B.3 Broughton Island

B.3 Broughton Island

APPENDIX B. 1 IQALUIT

A. General

A.1 Location

Latitude: 63° 45'N

Longitude: 68° 31'W

On Keejesse Inlet, near the northeast head of Frobisher Bay on Southern Baffin Island.

A.2 Community Information

Iqaluit is the largest community in the Eastern Arctic and the administrative and educational centre of the Baffin Region. It is also an important communications and transportation centre. It's modern international airport is serviced by three major airlines with daily flights from Montreal, Ottawa, Winnipeg and Yellowknife.

Population (1986): 2,947

Age Distribution (1985):		
0 - 4	13%	
5 - 15	19%	
15 - 64	66%	
65 +	2%	

Ethnic Distribution (1985):	Inuit	61%
	Dene/Metis	1%
	Others	38%

Note: 1989 population is 3,167.

A wide variety of services are available in Iqaluit including: 3 hotels, restaurants, a 35 bed hospital, an elementary school, a high school, Arctic College campus, a bank, a postoffice, Hudson Bay food and department store, 2 general stores, a country food store, an office supply store, Inuit co-operative shop, 2 travel agencies, a video store, art/craft stores and the Canadian Legion.

A.3 GEOLOGY AND TERRAIN

On rocky, irregular coastline in rocky lowland area, flanked by mountains on the northeast and southwest. Soils consist of glacial drift overlying Precambrian bedrock.

Area has a High water Table resulting in Pockets of ice lenses throughout the site.

A.4 CLIMATE

July mean high: 11.4°C
July mean low: 3.7°C

January mean high: -21.5°C
January mean low: -29.7°C

Winds NW in fall, SW in summer at 16.7 km/h.

Average Annual Precipitation: 19.2 cm rainfall
255.0 cm snowfall
34.8 cm total precipitation

B. MUNICIPAL SERVICES

B.1 Water Source

Water for the community flows from Lake Geraldine to a treatment plant and treated by chlorination, fluoridation, and filtration. The majority of the community is supplied by a piped utilidor and buried distribution system ulube, less than 1/3 receive water service.

B.2 SEWAGE DISPOSAL

Both on-line sewage disposal systems and vacuum truck/holding tank systems are used. A 15,436 L capacity and a 9988 L capacity vacuum truck provides pumpout service. Sewage is discharged into a sewage lagoon.

B.3 SOLID WASTE COLLECTION

Solid waste is collected by a 20 cu. yd. capacity E-2 pack compactor truck 5 days a week. Residents place bagged garbage in wooden containers by roadside. The wooden containers are provided to the residents by the NWT Housing Corp. and are of sufficient size to contain 2 or 3 bags of garbage. A wooden lid helps to keep ravens out of the garbage and prevents blowing wastes; usually 2 loads are collected in the morning and 1 or 2 loads are collected in the afternoon. Each resident receives garbage pick-up twice a week with many of the commercial establishments receiving daily service.

The Airport is serviced by the Town, but it still hauls much of its own garbage to the site. Many construction contractors haul their own wastes to the site as well.

B.3 SOLID WASTE DISPOSAL

Two solid waste disposal sites are being used by the Town; the west 40 dump and the North 40 dump.

Domestic and combustible wastes are deposited at the West 40 site about 11/2 km southwest of the town. It is located in a slight depression between rock outcrops directly adjacent to the Sea. The north side of the dump is fenced to control windblown debris. Some garbage is blown into the sea by north winds.

The south side of the dump is the working face. The compactor truck backs up to the edge of the working face and dumps its waste. The garbage is burnt by the collection crew at the end of each day. Each morning, a caterpillar 818 wheel dozer bulldozes wastes left by private individuals and contractors over the edge of the working face. Every fall, cover material is hauled to the dump site to cover the wastes. In the view of the foreman, the dump is too close to the water and should have been shut down years ago. Currently, the town is considering a new site along the road to Apex.

The metal waste area known as the North 40 Dump was originally used by the U.S. Military and covers an area of approximately ten hectares. A smaller site within this area is used by the town for current metal waste disposal. A large number of used oil drums are accumulated in this area. Access to the site is a problem in the spring because of large volumes of runoff inundating the access road.

APPENDIX B. 2 PANGNIRTUNG

A. GENERAL

A.1 LOCATION

Latitude: 66° 09'N Longitude: 65° 43'W

On the southeastern shore of Pangnirtung Fiord, in the Baffin Region.

A.2 COMMUNITY INFORMATION

Often referred to as "the Switzerland of Canada", Pangnirtung offers magnificent mountain scenery. As the gateway to AUYUITTUQ National Park and only miles away from Kekerton Historic Park, the Hamlet has developed into a major tourist area. Services include a hotel, a Hudson Bay food and department store, a general store, an Inuit co-operative, a weave shop, an elementary school and the new Angmarlik Visitors' Centre.

Population (1986): 1004

Age Distribution (1985):	
0 - 4	15%
5 - 14	30%
15 - 64	53%
65 +	2%

Ethnic Distribution:	
Inuit	95%
Other	5%

Note: 1988 population is 1,059.

A.3 GEOLOGY AND TERRAIN

On the remains of a tidal beach, old river delta and glacial drift. The Hamlet is bounded on the north and west by the fiord, on the south by steep hills and on the east by the Doval River.

A.4 CLIMATE

July mean high: 11.1°C	January mean high: -25.6°C
July mean low: 3.9°C	January mean low: -37.8°C

Winds E and W at 24 km/h.

Average Annual Precipitation:	16.2 cm rainfall
	180.3 cm snowfall
	34.8 cm total precipitation

B. MUNICIPAL SERVICES

B.1 Water Source

Water for the community is supplied from the Duval River. In the winter when the river is frozen over, water is supplied from a 71,000 m³ reservoir 1 km east of the community. In the summer, water is obtained directly from the river by water truck. Truck water delivery is provided three times per week using two 4540L capacity water trucks.

B.2 Sewage Disposal

There are approximately 240 buildings generating sewage in the Hamlet. Recent new construction and rehabilitation has resulted in the majority of the buildings receiving pumpout services. About 80 buildings use bagged sewage. Pumpout sewage is discharged to the ground about 100m above the high water mark at a location between the dump and the incinerator.

B.3 Solid Waste Collection

Solid waste is collected 5 days per week by a two man crew using a 12cu. yd. capacity Haul-All. Wastes are placed in 205L drums by the roadside to be collected. Many private individuals haul their own wastes directly to the disposal site, bypassing the incinerator. An informal survey estimates that 7 to 10 1/2 ton truckloads of waste building material were disposed each day during the construction season.

B.3 Solid Waste Disposal

Solid waste collected by the Hamlet is hauled to the incinerator about 1 km east of the community where the wastes are reduced before final disposal at the disposal site. The incinerator is a Consumat model C-225P with a capacity of 588 lbs/hr. Two men operate the incinerator full time, 5 days a week. The collection vehicle dumps the garbage onto the floor at the incinerator building and the attendants separate all combustible wastes. Only wastes small enough to fit in the 25 cu. ft. hopper are incinerated. Discussion with the foreman indicated that the incinerator was "down" 4 -6 weeks yearly due to malfunctions.

Ashes from the incinerator are hauled to the disposal site just east of the incinerator building. The disposal site occupies a slight depression but it is unfenced so blowing debris is evident all around the site. A gate was erected along the access road to the site in the past but has been knocked down. A separate area has been set aside for bulky waste disposal. The solid waste disposal site is covered with cover material once a year in the fall.

APPENDIX B. 3 BROUGHTON ISLAND

A. GENERAL

A.1 LOCATION

Latitude: 67° 33'N Longitude: 64° 02'W

On Broughton Island, off the east coast of Baffin Island, in Davis Strait.

A.2 Community Information

Broughton Island is located at the northern Gateway to the Pangnirtung Pass route through Auyuittuq National Park. The community residents enjoy a traditional lifestyle of hunting and fishing. There is a Hudson Bay food and department store, a hotel and an Inuit co-operative in this small community.

Population (1986): 439

Age Distribution (1985):	0 - 4 16%
	5 - 14 24%
	15 - 64 57%
	65 + 3%

Ethnic Distribution:	Inuit 97%
	Other 3%

Note: 1988 population is 472.

A.3 Geology and Terrain

On a rocky spur covered in glacial drift. Soils in this area are of fine rock silt mixed with beach sand and gravels.

A.4 Climate

July mean high: 7.4°C	January mean high: -19.9°C
July mean low: 1.4°C	January mean low: -26.4°C

Winds NW at 8.3 km/h.

Average Annual Precipitation:	3.7 cm rainfall
	250.0 cm snowfall
	28.8 cm total precipitation

B. MUNICIPAL SERVICES

B.1 Water Source

Broughton Island receives its water from the Tulugak River. The river is a glacial stream which empties into the sea approximately 2.5 km east of the community. The water is gravity fed into a storage reservoir and from here it is fed to a truck filling station where it is chlorinated and then distributed to the community by a 4550L capacity water truck.

B.2 Sewage Disposal

Sewage from buildings equipped with sewage holding tanks are pumped out three times a week by a 4540L capacity sewage pumpout truck. The pumpout sewage is hauled to the dumpsite where it is deposited into a pit. Sewage from the pit flows approximately 300 m into the sea.

B.3 Solid Waste Collection

Garbage is collected 5 days per week by a crew of two men using an uncovered 3/4 ton U-Haul. Wastes are placed in 205L oil drums by the roadside for collection. 23 buildings remain on the honey bag system. Honey bags are collected using the same vehicle as for the garbage but not at the same time.

B.3.1 Solid Waste Disposal

The disposal site is located 2 km east of the community about 350 m from the sea. The collected wastes are dumped off the edge of an elevated gravel "turnaround" pad onto the working face of the disposal site. At the end of each work day, the wastes are burned to help reduce volume and prevent windblown debris. Once a week a Caterpillar D-6 bulldozes the waste against the working face. Once a year, in the fall, the waste is covered with gravel. There were no signs of fences around the disposal site, as a result paper and other wind blown wastes were scattered all around the surrounding area.

Presently, the dump is considered to be too close to the beach and the Hamlet is considering moving the dump soon.

